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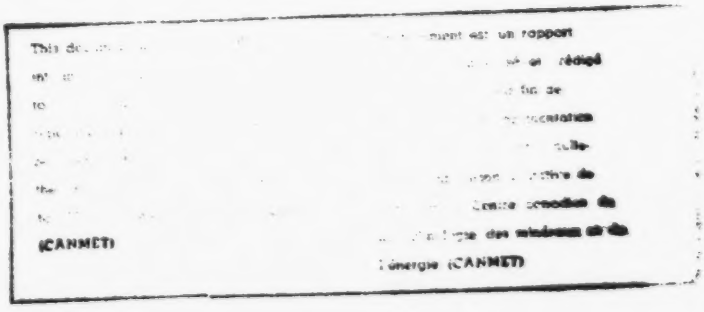
SURVEY OF MICROPROCESSOR BASED PERFORMANCE MONITORING DEVICES IN CANADIAN SURFACE COAL AND OILSANDS MINES IN 1987

H.G. Naidu,

July, 1988



COAL RESEARCH LABORATORIES
DIVISION REPORT CRL 88-48 (TR)

MICROMEDIA

SURVEY OF MICROPROCESSOR BASED PERFORMANCE MONITORING DEVICES IN CANADIAN SURFACE COAL AND OILSAND MINES IN 1987

by

H.G. Naidu*

ABSTRACT

This report presents the findings of an industry survey carried out to determine the current status of microprocessor based devices used for monitoring surface mining equipment. There seems to be a general awareness in the industry towards the usefulness of this emerging technology. Some of the larger coal and oilsands mining operations have installed these devices on larger equipment. However, except for a handful of older units many devices are still going through a process of field evaluation.

At present, microprocessor devices are being used on draglines, bucketwheels and belt conveyors to provide information on equipment performance parameters. Recent developments include installations on blasthole drills, shovels and off-highway trucks. During the past year, second generation, more sophisticated monitors have been provided on draglines. Such devices are becoming an integral part of the equipment and are now included as a standard component in equipment specifications.

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ENQUETE SUR LES DISPOSITIFS DE CONTROLE DE LA PERFORMANCE A MICRO-PROCESSEURS DANS LES MINES CANADIENNES DE CHARBON ET DE SABLES PETROLIFERES A CIEL OUVERT EN 1987

par

H.G. Naidu*

RESUME

Le présent rapport présente les résultats d'une enquête menée auprès de l'industrie pour déterminer l'état actuel des dispositifs à microprocesseurs utilisés pour contrôler le matériel d'exploitation minière à ciel ouvert. Il semble que l'industrie a pri conscience en général de l'utilité de cette technologie naissante. Certaines exploitations de charbon et de sables pétrolifères parmi les plus grandes ont doté leur matériel le plus gros de tels dispositifs. Cependant, saud pour une poignée de machines plus anciennes, un grand nombre de dispositifs font encore l'objet d'une évaluation sur le terrain.

Des dispositifs à microprocesseurs sont actuellement utilisés sur des draglines, des roues à augets et des convoyeurs à courroie pour renseigner sur les paramètres de performance du matériel. On a réussi récemment à installer de tels dispositifs sur des foreuses de trous de sonde, des pelles et des camions tous terrains. Au cours de l'année écoulée, des contrôleurs plus perfectionnés ont été installés sur des draglines. De tels dispositifs sont de plus en plus intégrés à l'équipement et sont maintenant inscrits comme composantes standard dans les spécifications de l'équipement.

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INTRODUCTION

It is recognized that microprocessors help in improving the performance of surface mining equipment by providing timely information on equipment health and performance. This recognition has not come easily. Equipment manufacturers had to improve on their original designs to make these devices more suitable for the rugged mining environment. At the same time they had to demonstrate that real tangible benefits result by application of such devices. It has taken nearly ten years of development and field trials to produce the reliable off the shelf units that are now available with varying degrees of sophistication to meet customer requirements and cost. Last year the Surface Mining Laboratory of CANMET carried out a general survey of the microprocessor devices available from the shelf. These were described in CANMET's Divisional report CRL 87 - 13(TR), titled "An Overview of Microprocessor Based Systems for Monitoring Equipment Performance", which was circulated to the surface mining industry. Since then there have been further developments including several installations in Canadian mines. A survey was carried out amongst Canadian mines through questionaire (appendix-I) and discussion to determine the acceptance, type and industry experience with these devices. This report documents the findings of this survey and is based on the information provided by the users. It also describes several similar products suitable for performance monitoring.

STATUS OF ON-BOARD MONITORING DEVICES

Draglines

There is a growing interest in the coal industry towards dragline monitoring. Syncrude Canada installed the first generation of monitoring devices on their four draglines ten years ago. Known as "Digmate" these are manufactured by General Electric Co. of Pa., U.S.A. and provide information on bucket load, shovel cycle time, and the power consumed. A CRT screen in the operator's cabin displays this information graphically for easy comprehension by the operator. Memory Cartridge in the Digmate can store data for 85 shifts. Data can be retrieved by a main computer for generating reports for management. At Syncrude, the 'Digmate' has helped in handling

dirt bands in the ore more accurately, resulting in better quality feed grade ore. The data generated by the device has proved useful in production performance evaluation and maintenance.

The original sensing units were causing some problems at Syncrude but these have since been rectified. Currently the Syncrude engineers are in the process of designing in-house monitoring units with added features. In-house work is also in progress to link the four field units to the main computer in the central office.

In July 1987 a modified version called "Digmate Plus" also supplied by General Electric was installed on a Marion 8750 dragline at Highvale mine, Alberta. The additional features of this unit are an automatic overriding control to protect draglines from damage caused by overloading the bucket and excessive bucket travel speed and immediate evaluation of operator's performance compared with standard operating practices (useful tool for training). At Highvale mine, initially, this unit ran into some problems caused by mechanical breakdowns. A full evaluation of this unit is expected by the end of 1988. Another operator in western Canada is also actively pursuing the use of this unit.

There is no doubt dragline monitoring devices are gaining acceptance in the mining industry. As more experience is gained and confidence builts up modified versions at much reduced cost will be available to make them more attractive and acceptable to the industry. Several mining operating companies are also building their own units. Transmission of field data from the dragline monitors to a Central unit in the main office is another aim to be achieved; progress is already visible on this front. Table-1 shows the result of the survey conducted in 15 mines:

Table-1 - Dragline Monitors

Model	Mines Survd.	Mines using	Monitors in use	Performance well	Performance not well	Under test	Mines consi-dering	Instaln. planned for 1987
Digm--ate	15	2	5	4	-	1	1	5
Total	15	2	5	4	-	1	1	5

Bucketwheel Excavators

In Canada only the two oilsands mines in Alberta namely Suncor and Syncrude use bucketwheel excavators, Suncor for extraction and Syncrude for reclaiming oilsands from their stockpiles. Syncrude have installed a programmable Logical Controller "Allen Bradley PLC 3" on each of their four machines. It is an in house design to match user's specifications. It gives information on the condition of the machine e.g. oil pressure, amps drawn by conveyors and production. The performance of these units as reported is satisfactory. Plans are underway to link the four units to the main computer.

Several manufacturers of bucketwheels have developed on-board computer monitoring systems for bucketwheel excavators - reclaimers. These systems control the bucketwheel's motions and provide information on machine health and performance. The bucketwheel can also be programmed to cut within a specified cut geometry.

Shovels

Microprocessor based health and performance monitoring devices have been in use on conventional shovels for several years. A variety of units incorporating different set of computers and hardware to perform a variety of data logging and analysis are nov available. The three manufacturers who have been most active in this area are Harnischfeger P&H, Bucyrus Erie (BE),

and Interactive Sciences (IS). Several units supplied by these manufacturers are operating world-wide. Recently, General Electric has designed a model called SPM 8000. One such unit is at present undergoing tests along with two other units (Bepal II of BE and model 173 of IS) in Canadian coal mines.

The basic features of all these units are similar. These on-board devices gather information on bucket load, shovel cycle time and amperes drawn and on demand produce shift and daily reports. The bucket load information helps the operator to accurately load the trucks. Information on machine's operating condition helps in providing timely information on its correct usage and maintenance required. Table 2 shows the present status of different monitoring devices in the Canadian coal and oilsand mines.

According to the industry survey, the units in use have run into operational problems which include:

- failure to give accurate load measurement,
- difficulty in providing steady voltage/amperage to the device from the shovels, and
- problem with high voltage.

Efforts are being made to overcome these problems.

The ACET Ltd. of Australia have designed a Shovel Performance and Report Compiler (SPARC). As mentioned in (3), "SPARC is a computer-based data gathering system for open cut mines using electric rope shovels. The data logged is displayed to the shovel operator and simultaneously transmitted to the base computer by a radio link. It provides the operator with a means of loading trucks to within predefined limits without interfering with the normal production cycle".

Table 2 - Shovel Monitors

Model	Mines Survd.	Mines using	Monitors in use	Performance well	Performance not well	Under test	Mines considering	Installn. Planned for 1987
Bepal II	22	4	5	0	3	2		
GE SPM 8000	22	1	1	0	-	1		
Model 173 of Int.Sc.	22	1	1	0	-	1		

Several other manufacturers (Mannesmann Demag, Komatsu, and Dresser) have also designed similar devices but these have not been tried in Canadian coal or oilsand mines.

Drills

The monitoring devices for drills have contributed in two ways. First, it has helped in improving the drilling performance and second, the information on strata being drilled serves as a useful guide for designing blasts. At present four models are known to be in use in the mining industry namely Holepro of Bucyrus Erie, Model 245 of Interactive Sciences, Drill Efficiency Indicator (DEI) of GLI corporation and DR-20 of Instantel(Ins.). The first three models provide very similar information: hole depth, penetration rate, rotary torque, speed and hydraulic pulldown. The DR-20 designed by Instantel in addition provides information on inclination and direction (north/south and east/west) of holes. The most common unit in operation at Canadian coal mines is DEI with or without a stratalogger. At one coal mine work is underway for designing an in-house

model for this purpose. Table 3 shows the present status of different drill monitoring devices in Canadian coal and oilsand mines.

Table 3 - Drill Monitors

Model	Mines Survd.	Mines using	Monitors in use	Performance well	Performance not well	Under test	Mines consi-dering	Installn. planned for 1987
DEI (GLI)	12	4	6	3	3	-	1	8
Hole-Pro (BE)	12	1	1	-	-	1	-	1

The DR-20 drill monitors are currently operating at three metal mines and planned for one more. At Quintette mine, two DEI units were installed but due to frequent troubles they had to be withdrawn. Work has been initiated through the Modular Mining System (MMS) of Arizona to develop an in-house system and integrate it with the existing MMS despatch system.

At Fording River mine, a co-operative R & D project is in progress to integrate shovel and drill monitoring systems for increasing mine productivity. This work is being undertaken under a University - Industry program by a grant provided by Natural Sciences and Engineering Research Council (NSERC). CANMET is assisting in this work by providing the "Polycorder" electronic data logger. The objective of the two years study is to evaluate the existing monitors (GE's SPM 8000 shovel monitor and Solroc Consultants Inc.'s Automated Drill Monitor), improve the technology and software framework and develop an integrated drill/shovel data collection and analysis system which will be suitable for field use in the rugged mining environment.

Trucks

Underloading and overloading of trucks are detrimental to mine operating costs. The former due to a drop in productivity and the latter due to an eventual increase in maintenance costs. This suggests that accurate loading can play a role in reducing cost. Several payload measurement systems (PMS) have been designed by different manufacturers and tested under rugged mining conditions. Known manufacturers are Philippi Hagenbuch Inc., Modular Mining Systems, GLI corporation, Unit Rig and Caterpillar. Some manufacturers are now aiming at a more comprehensive package to include truck dispatch along with on-board monitoring of individual trucks.

For the past four years, CANMET has been investigating truck/shovel management systems and initiated a program for field testing at a Canadian coal mine in 1987. The On-board Data Acquisition System (OBDAS) of Philippi-Hagenbuch Inc. was installed on two trucks at Gregg River Mine, Alberta. The details of the system and results of the field trial are provided in a CANMET report (5). The field trial showed that by using OBDAS average load per cycle increased from 55.3 to 57.3 BCM. At Gregg River handling some 12 million BCM per year this could provide an annual saving of nearly 240,000 dollars. As mentioned in the final report (5),"the test also established that this system is accurate, dependable and has the ability to develop the information base and real time monitoring to develop a dispatching system".

Fording Coal Ltd. is currently assessing the three options for truck dispatching; manual, semi-automatic and automatic. Bullmoose mine is also reviewing the benefits involved in introducing such a system and if the decision is positive, an in-house product would be designed and installed.

Recently, a monitoring device for heavy equipment has been designed by Advanced Electronic Systems Ltd., Ontario. Some of the units have been installed on logging trucks at Port Alberny, B.C and are undergoing tests. The different features of this system are provided in Appendix-II.

The Marathon LeTourneau company have also designed vital signs monitor (VSM) specially for Titan-2000 series trucks, LeTourneau loaders and similar heavy duty equipment. It is a microprocessor based system consisting of a digital display, information gathering sensors and a 16-bit microprocessor for processing. The system continuously monitors the health

and performance of the equipment and activates a buzzer on out-of-limit or alarm conditions. The computer stores the information which could be unloaded onto the main computer or directly linked to it through a dispatch radio system for producing reports. For accurate loading of trucks, an additional module called load weighing system (LWS) has been designed which could be linked with VSM. There is also a three lamps assembly which helps the loader operator to load very close to the designed load (6).

Backhoes

Bullmoose mine has two programmable Logic Controllers (PLC) sensing units installed on the backhoes. These are of in-house design for monitoring the condition of motors, engine and hydraulics. The system also gives an alarm signal when there is a problem with any of these. In case of serious malfunctions it trips the power automatically.

CONCLUSIONS

In general there is great thrust in the Canadian coal and oilsand industries to optimize the performance of mining equipment. The introduction of monitoring devices though recent, is gaining increasing attention. The computer technology is advancing very rapidly providing more versatile and powerful units. The time is approaching when in the not too distant future most mine equipment will be monitored through a central minewide management system. Input from units operating at different locations in the pit will be transmitted to a central data gathering point. This coupled with TV cameras and screens will provide comprehensive mine wide monitoring.

The Surface Mining Laboratory of CANMET continues to survey and monitor the upcoming technology in microprocessor devices and their use to surface mining equipment. This report is a summary of the current usage of these devices in Canadian coal and oilsands mines. Periodic reports will be issued updating this information and providing reports on new developments.

ACKNOWLEDGEMENT

The author expresses his sincere thanks to the management of the surface coal and oilsands operations who have provided the information in preparing the report.

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4. Advanced Electronics Systems Ltd. "Smart Operator", Heavy Equipment Monitoring, a company brochure.

5. Gregg River Resources Ltd., "Demonstration and Evaluation of an Integrated Truck Management System in a Producing Canadian Surface Coal or Oilsands Mine", final report, January 1988.

6. Marathon Le Tourneau's brochure, "Vital Signs Monitor Plus Road Weighing System."

APPENDIX I - QUESTIONAIRE

Name of Mine: _____
Mine Office Address: _____
Name of Mine Supdt./Mine Manager: _____
Mining Method: _____
Dragline: _____ Truck/Shovel: _____ Others: _____
Annual Production (R.O.M.) _____ tonnes

Microprocessor based Devices (Units)

Specific Information:

Name of Device	Number in Use	Number Expected in Use by end of 1987	*General Comments
Shovels: e.g. Bepal II			

Name of Device	Number in Use	Number Expected in Use by end of 1987	*General Comments
Draglines: e.g. Digmate			

Name of Device	Number in Use	Number Expected in Use by end of 1987	*General Comments
Trucks: e.g. OBDAS			

Others:

Name of Production Equipment	Name of Device	Number in Use	Number Expected in Use by End of 1987	*General Comments

Mine contact person for additional information:

_____
_____
_____
_____
_____

*General Comments:

- Future trends and needs
- Performance of units (effect of cold temperatures, vibration, loading etc.)
- Maintenance and spare parts
- Operational and economic benefits
- List of outputs that you use or want

For further information please contact:

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Surface Mining Laboratory/CANMET
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April 27, 1987

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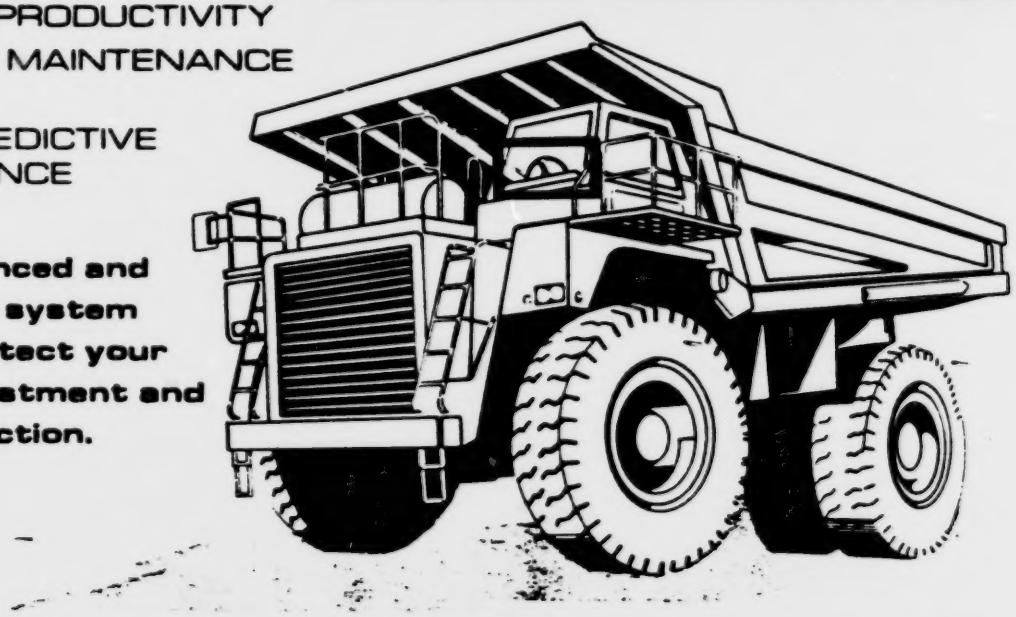

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* COMMUNICATIONS

Built in communications transfers data from the equipment to the base station. Options include: internal FM transmitter and receiver, internal modem for external radio, infrared transceiver, and removable data cartridge.

* BASE STATION

An IBM [TM] PC with our diagnostic and production reporting software polls a fleet of equipment to obtain operating and maintenance data.

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Humidity: 10 to 100%
Vibration: Mil 810C

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Pulse: 6
Digital: 24

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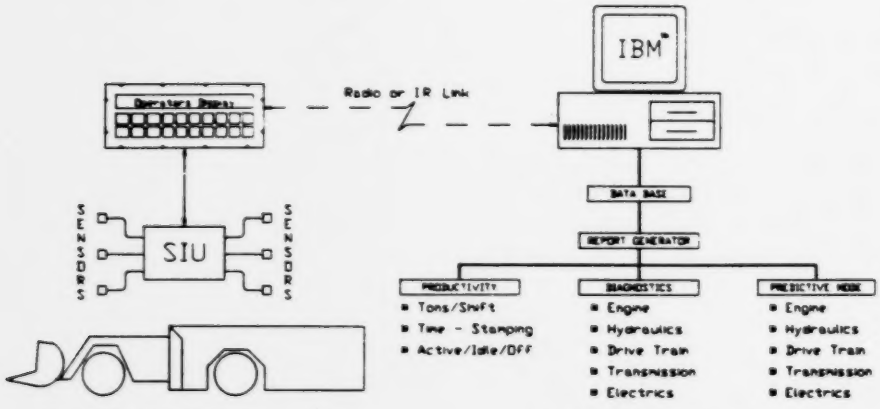
RS 232C Port — RF Modem Port
Bell 212 Modem Port — Infrared Port

Display 24 character, alpha numeric LED type, scrolling

Keypad Sealed Membrane Switch
10 numeric keys
6 programmable special function
4 data entry/edit



ON-BOARD EQUIPMENT **BASE STATION**

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